



Armed Forces College of Medicine AFCM



DEVELOPMENT OF CVS (II) [PARTIONING (SEPTATION) OF THE HEART]

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INTENDED LEARNING OBJECTIVES (ILO)



- At the end of this lecture, students should be able to:
 - i. Describe partitioning (septation) of the heart and formation of the interatrial septum, interventricular septum & other septa.
 - ii. Explain congenital anomalies of the heart & great vessels.

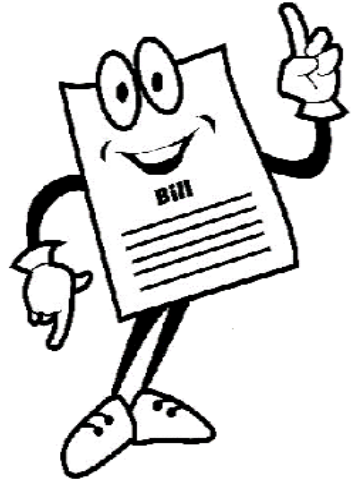
Key points



1. Partitioning of atrio-ventricular (AV) canal
2. Formation of the interatrial septum
3. Formation of the interventricular septum
4. Partitioning of cono-truncal region of the heart
5. Anomalies of the heart & great vessels

Introduction

WATERCOOL

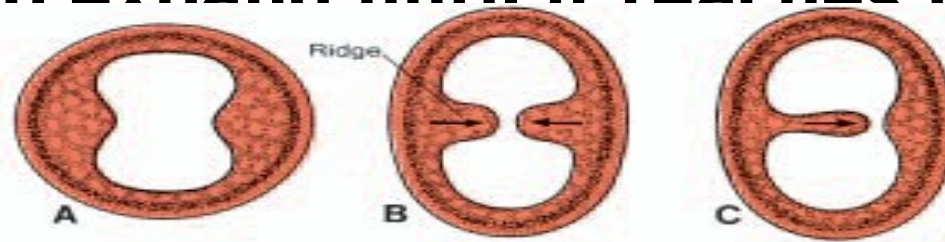


♣ **Partitioning of the heart & formation of the cardiac septa starts at 4th week & is completed by 8th week.**
6 septa

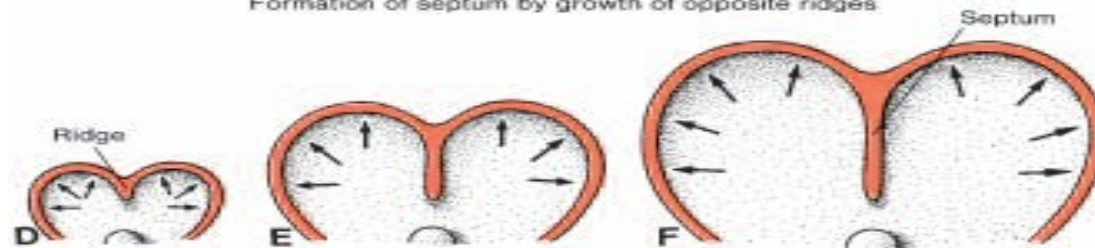
-They are formed by 1 of 2 methods:

1- 2 actively growing masses of tissue that approach each others until they fuse dividing the lumen into 2 canals.

2- active growth of a single tissue mass that continue to expand until it reaches the opposite side of t



Formation of septum by growth of opposite ridges



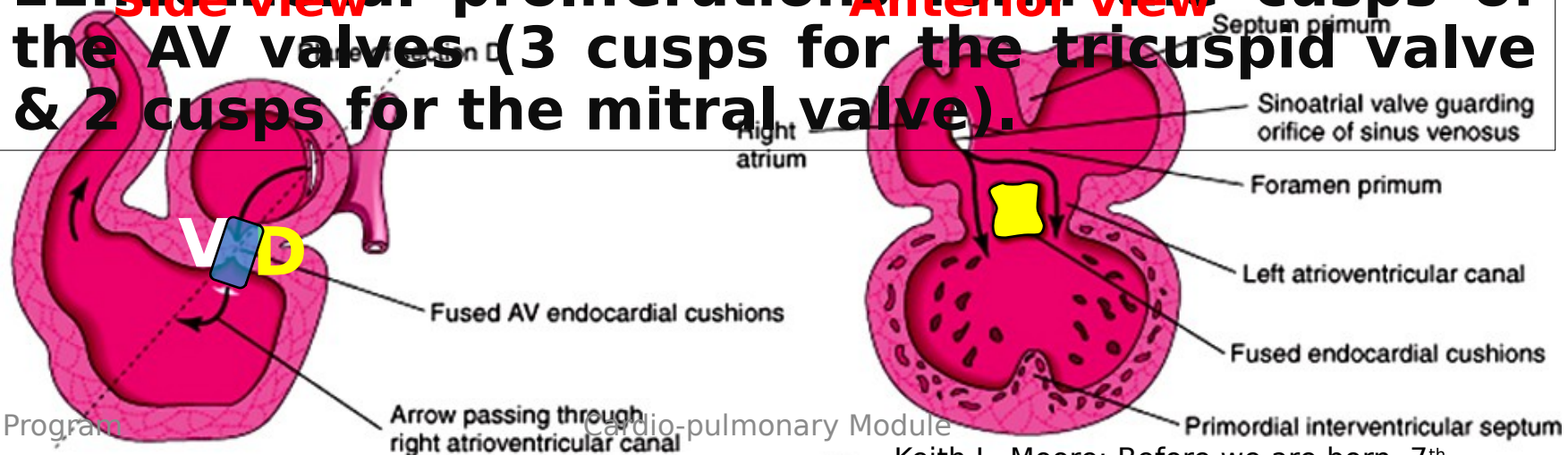
I. Partitioning of atrio-ventricular (AV) canal:

.It is an elongated connection between the atrium & ventricle.

-2 **endocardial cushions**; ventral & dorsal project from the ventral and dorsal walls of the canal respectively.

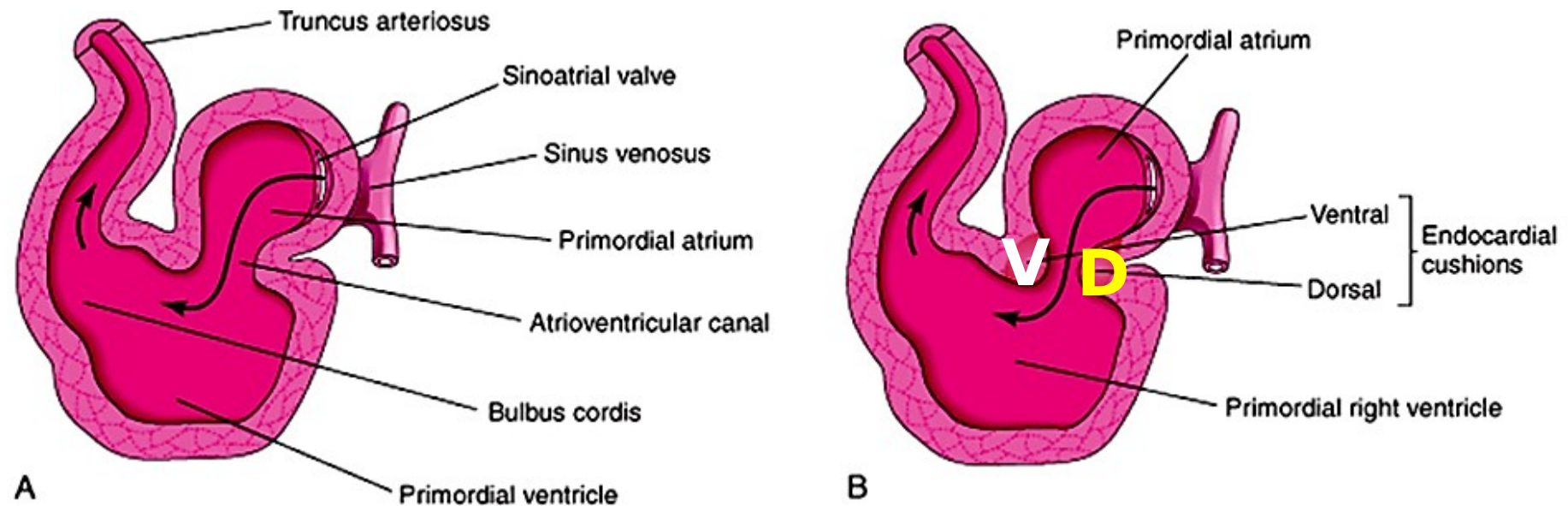
-The cushions grow & fuse together forming the **septum intermedium** which divides AV canal into right & left parts.

■ Endothelial proliferations form the cusps of the AV valves (3 cusps for the tricuspid valve & 2 cusps for the mitral valve).



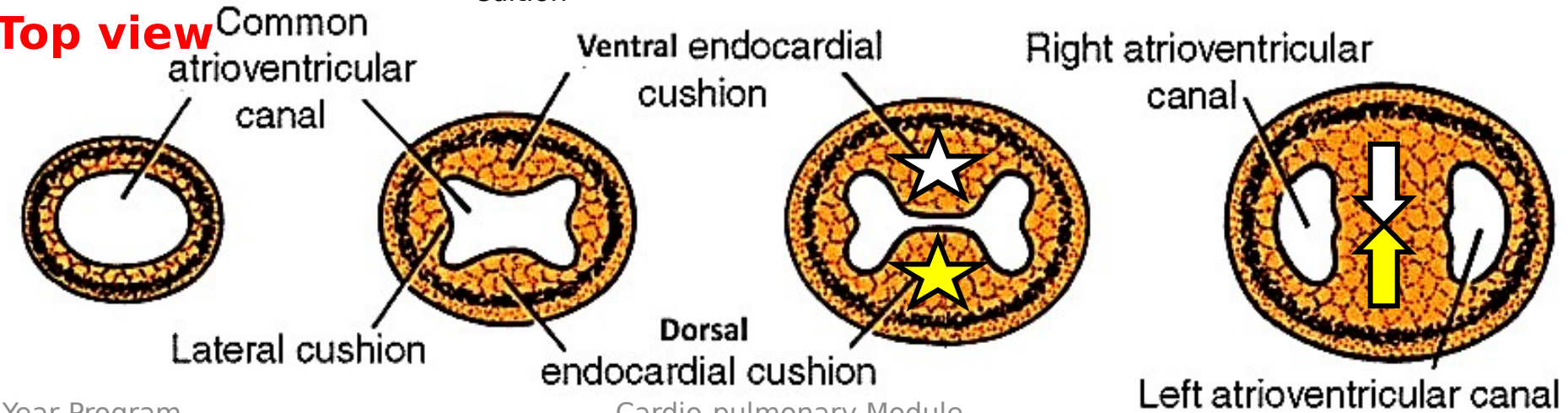
Partitioning of AV canal

Side view



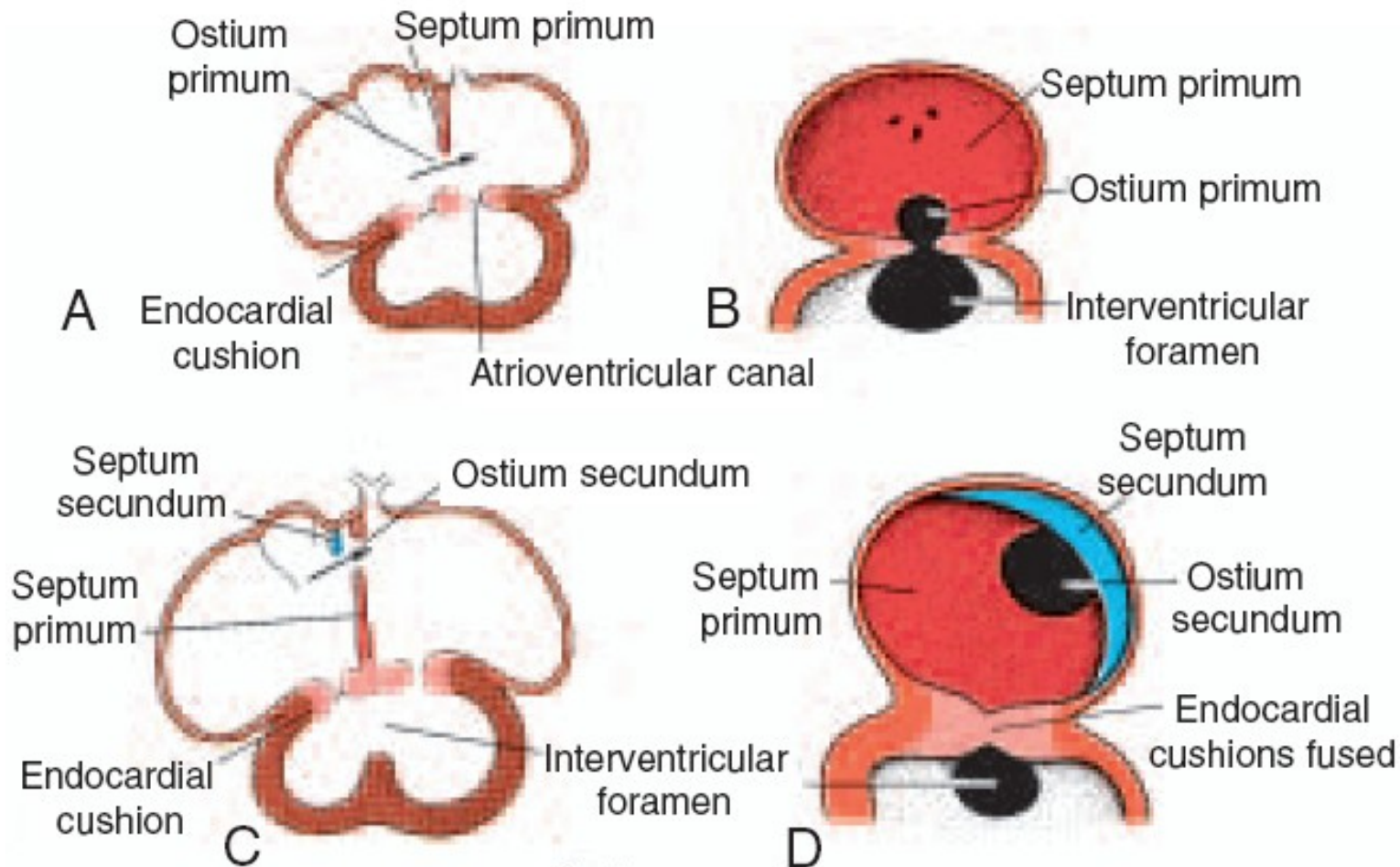
Keith L. Moore: Before we are born, 7th edition

Top view



II. Partitioning of the primitive atrium: [Formation of the interatrial septum]

-The primitive atrium is divided into right & left atria by the formation, modification & fusion of 2 septa; the



Wardlaw

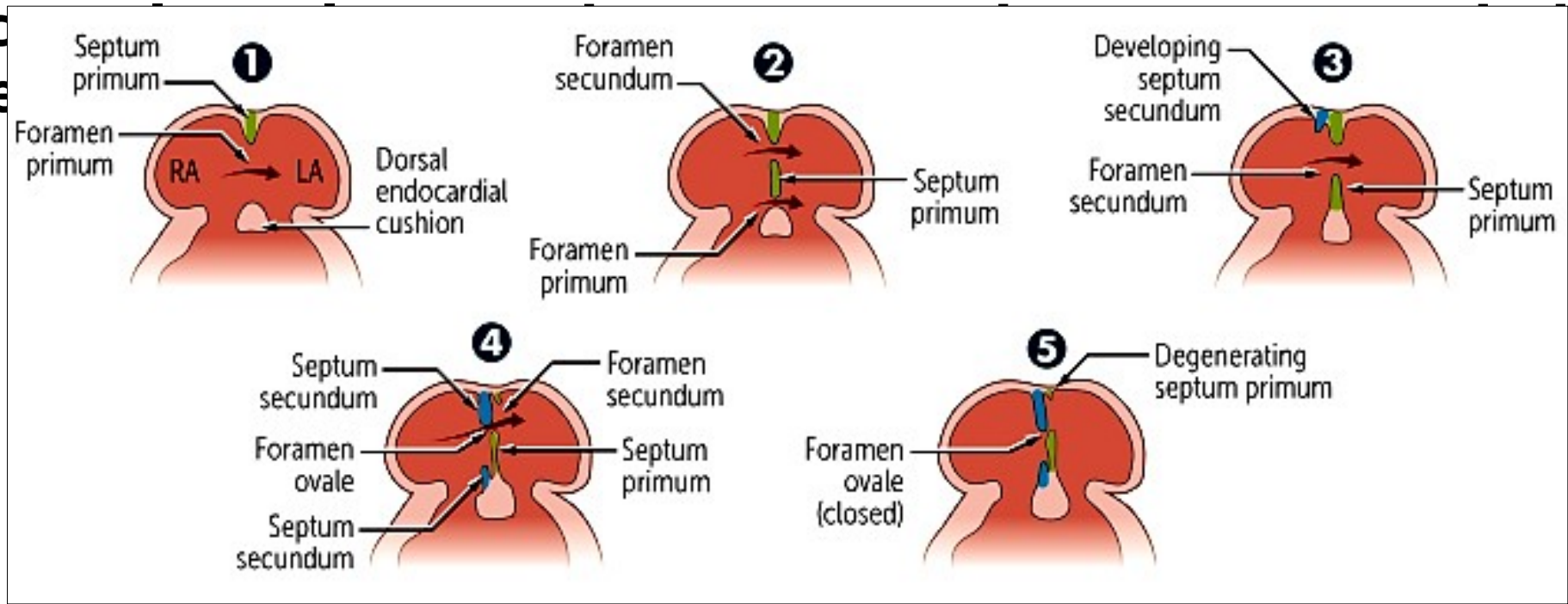
Septum Formation in the Common Atrium:

1- The Septum Primum:

- It is a membrane which grows from the dorso-cranial wall of the atrium.
- It descends towards the septum intermedium but is separated from it by the **foramen primum (ostium primum)**.
- The foramen primum becomes progressively smaller and is finally closed.
- Before c

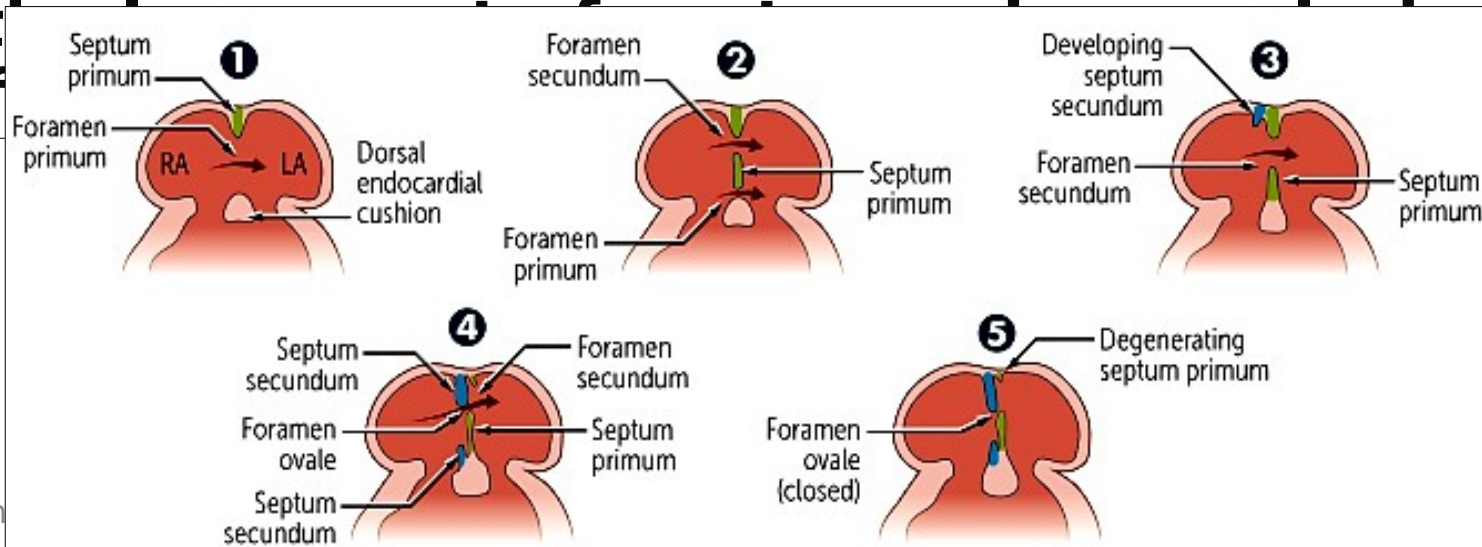
forming the

ts center

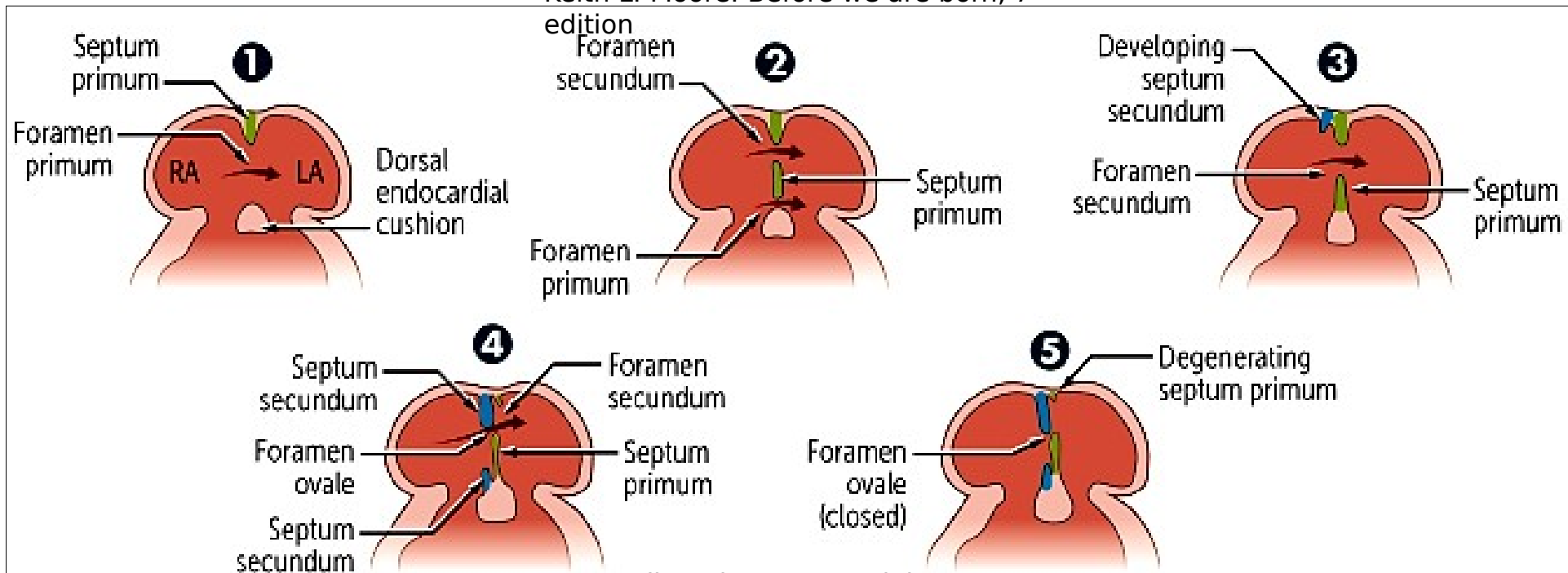
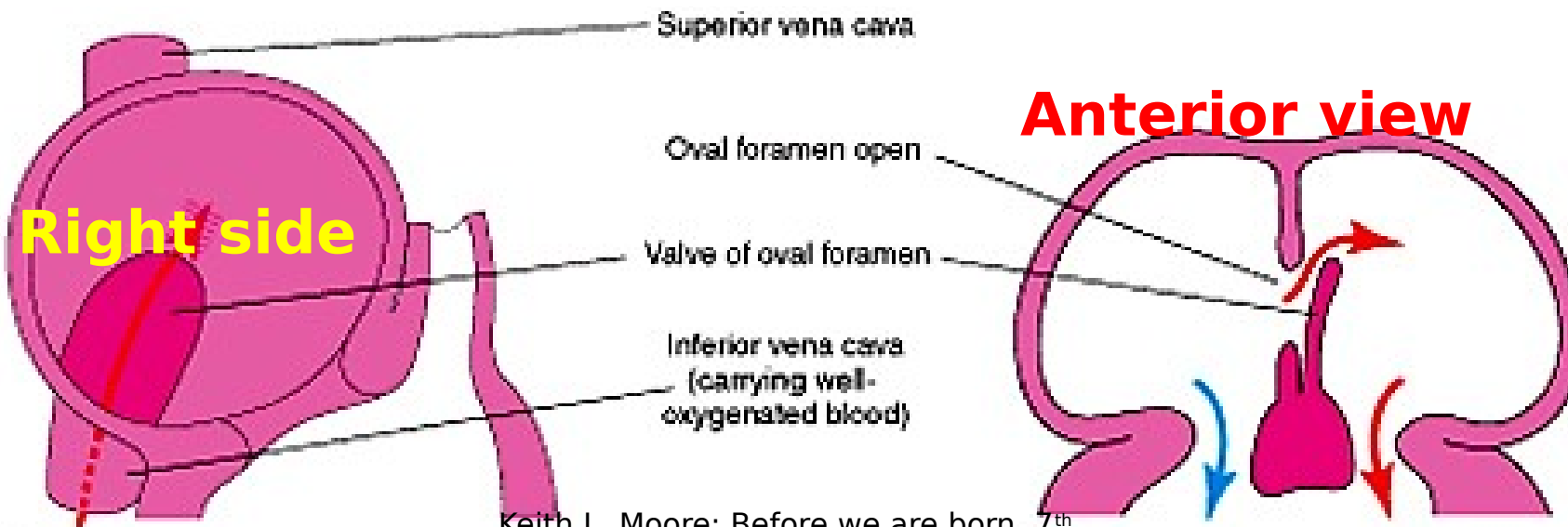


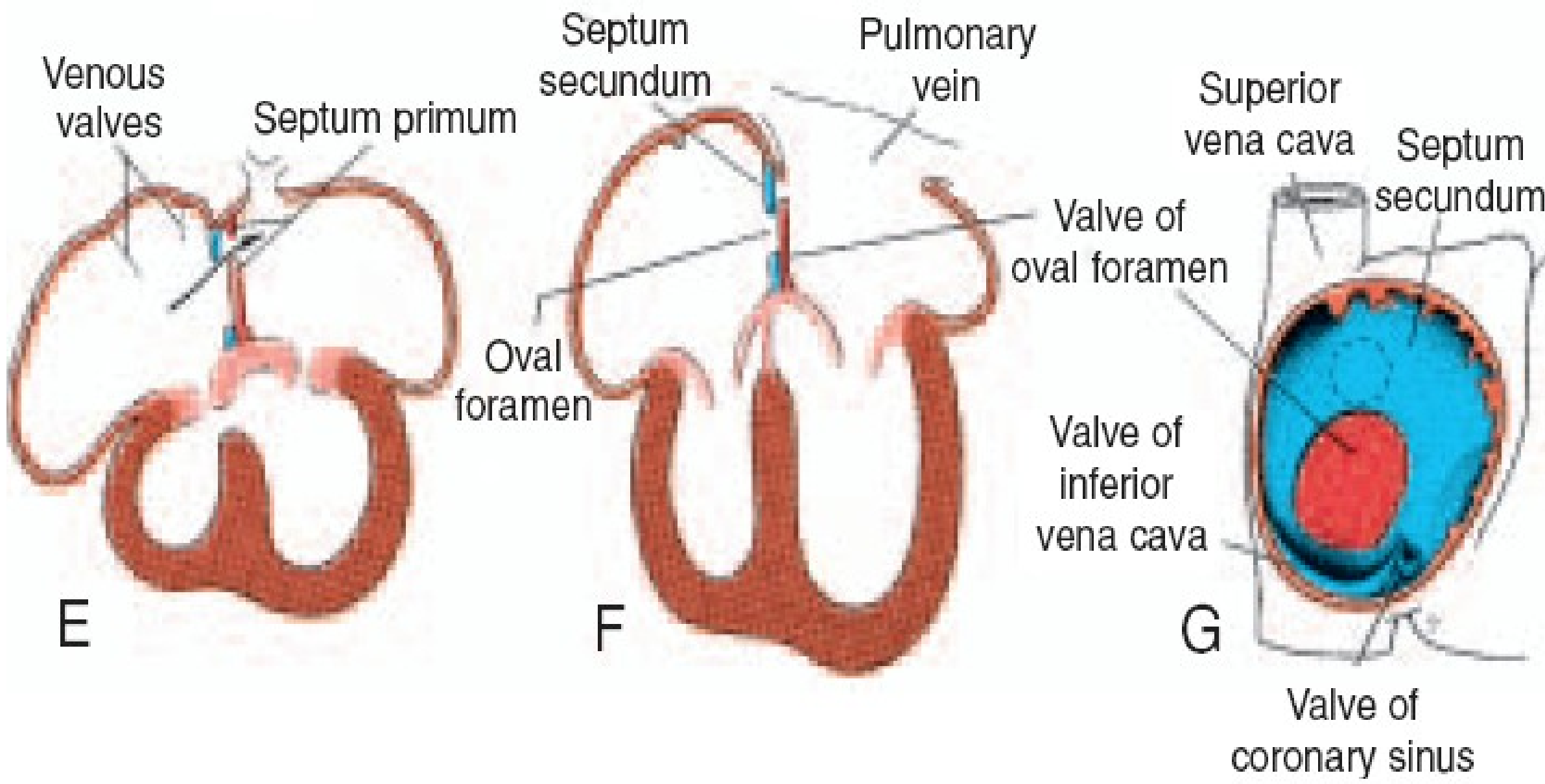
2. **Septum secundum:**

- Another thick crescentic membrane grows immediately to the right side of the septum primum.
- The opening below the septum secundum is called the **foramen ovale**.
- It gradually overlaps the foramen secundum in the septum primum.
- Blood in the right atrium passes to the left atrium via a tortuous S-shaped course through the foramen ovale → foramen secundum.
- Passage of blood in an opposite direction is prevented by the valve like action of the septum primum, the foramen

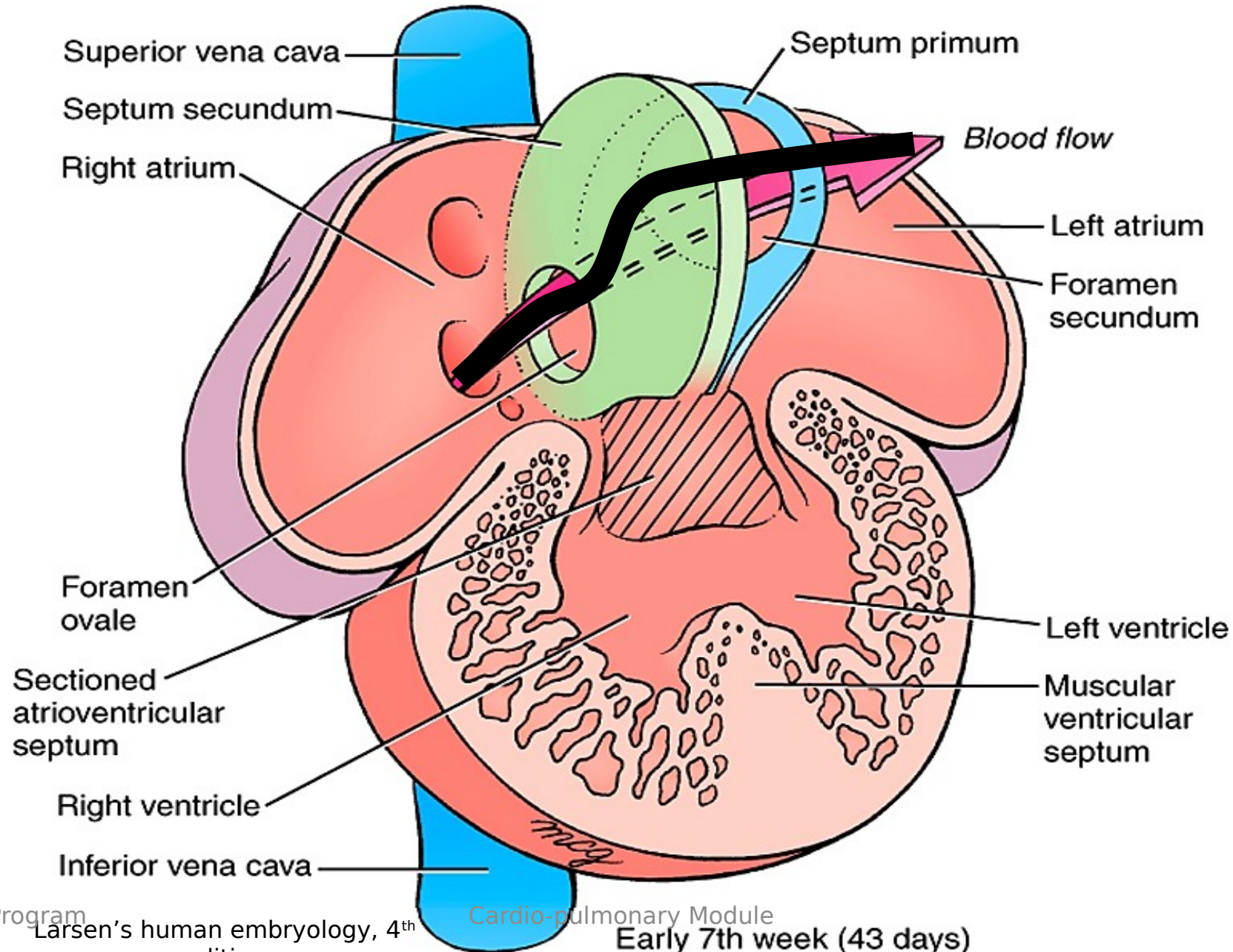


Development of interatrial septum



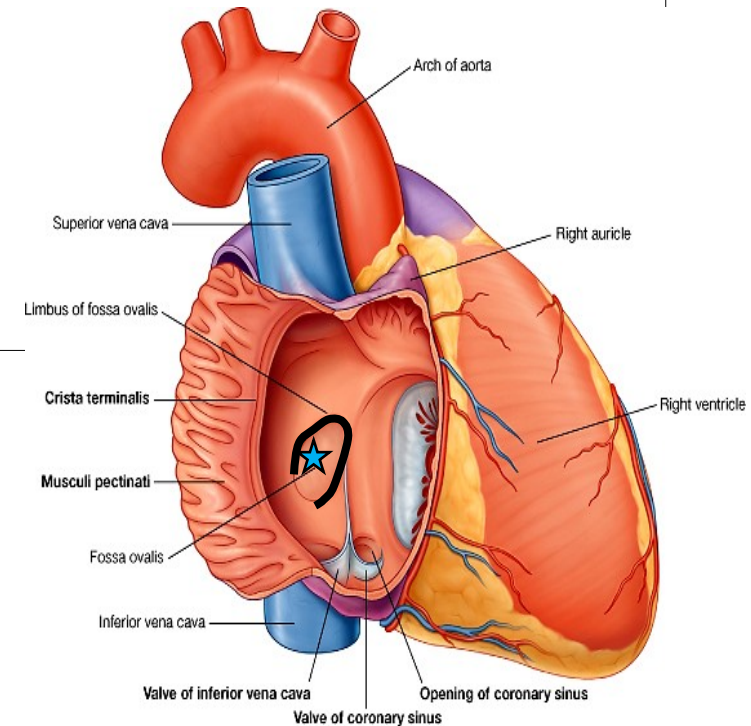
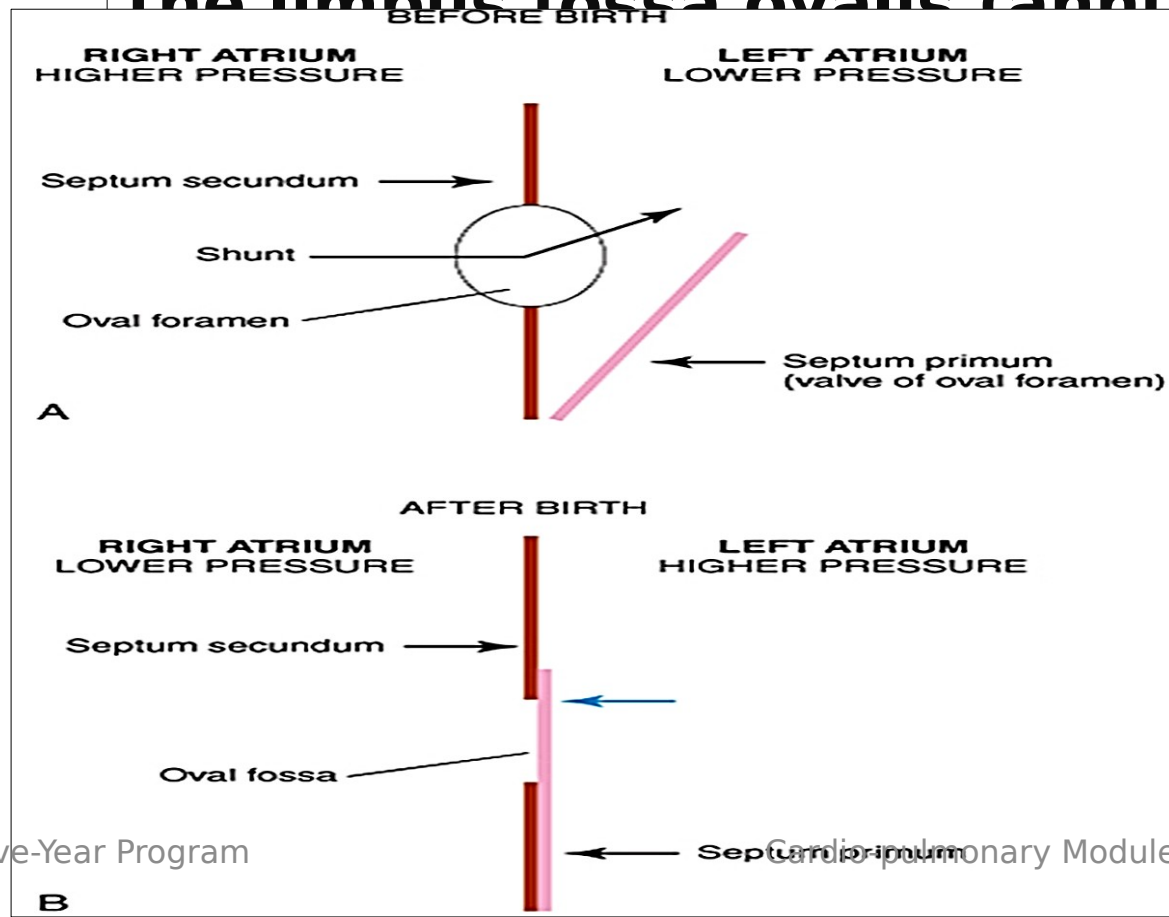


Septum primum & septum secundum



■After birth, the pressure in both atria becomes equal and the 2 septa fuse.

-The septum primum in the site of the foramen ovale forms the fossa ovalis. The margins of the septum secundum around the fossa form the limbus fossa ovalis (annulus ovalis).



Important note



-Right atrium develops from 3 sources:

1.Right $\frac{1}{2}$ of primitive atrium \Rightarrow Anterior rough part including the right auricle.

2.Right horn of sinus venosus \Rightarrow Posterior smooth part (sinus venarum).

3.Upper part of the left atrio-ventricular canal.

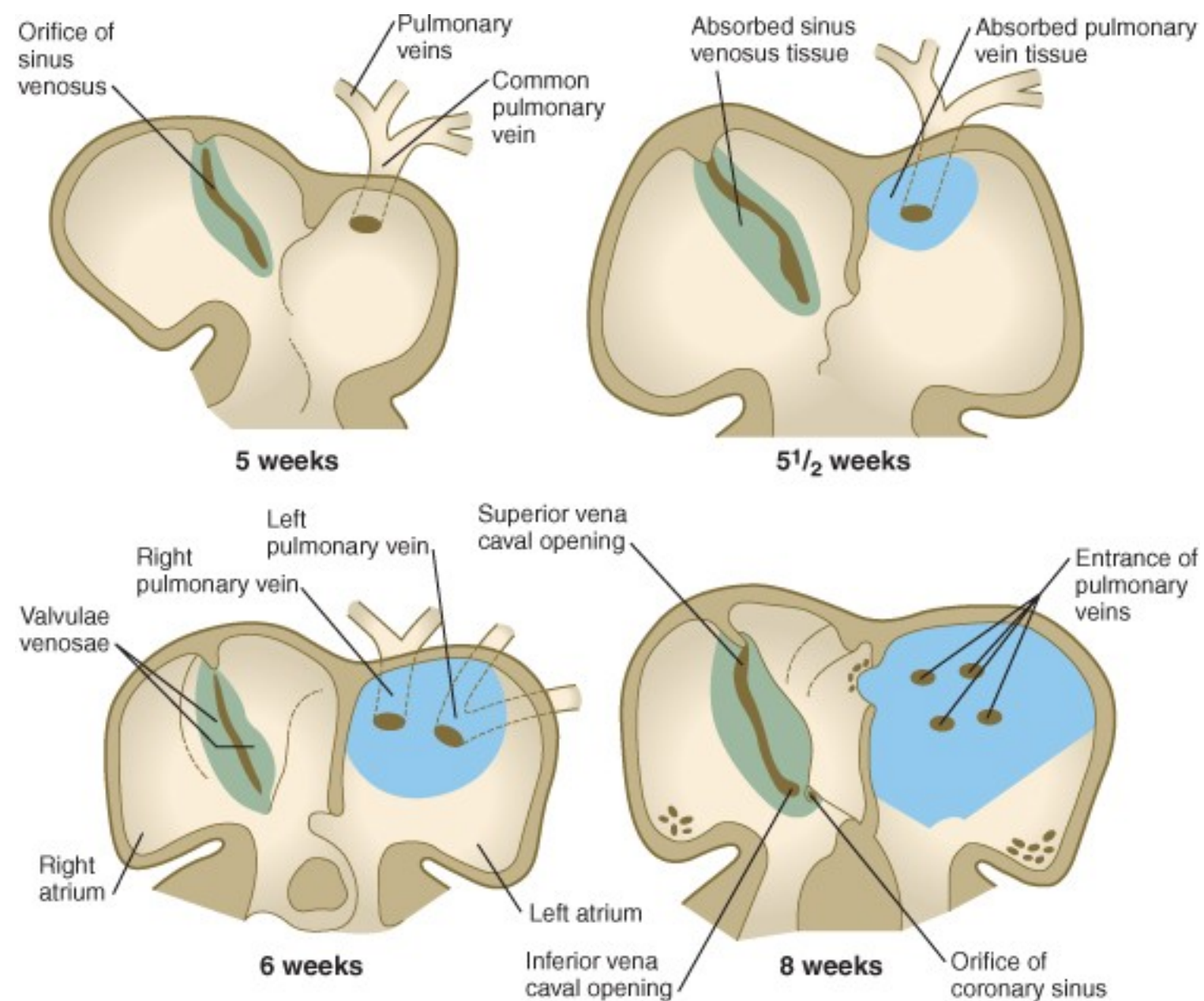


-Left atrium also develops from 3 sources:

1.Left $\frac{1}{2}$ of primitive atrium \Rightarrow Left auricle.

2.Absorbed pulmonary veins \Rightarrow Its major smooth part.

3.Upper part of the left atrio-ventricular canal.



Quiz



- **Mention 2 cardiac septa sharing in portioning of the primitive atrium during 4th - 8th week of development.**
- **Enumerate the primordia (sources) of:
Right atrium - Left atrium**

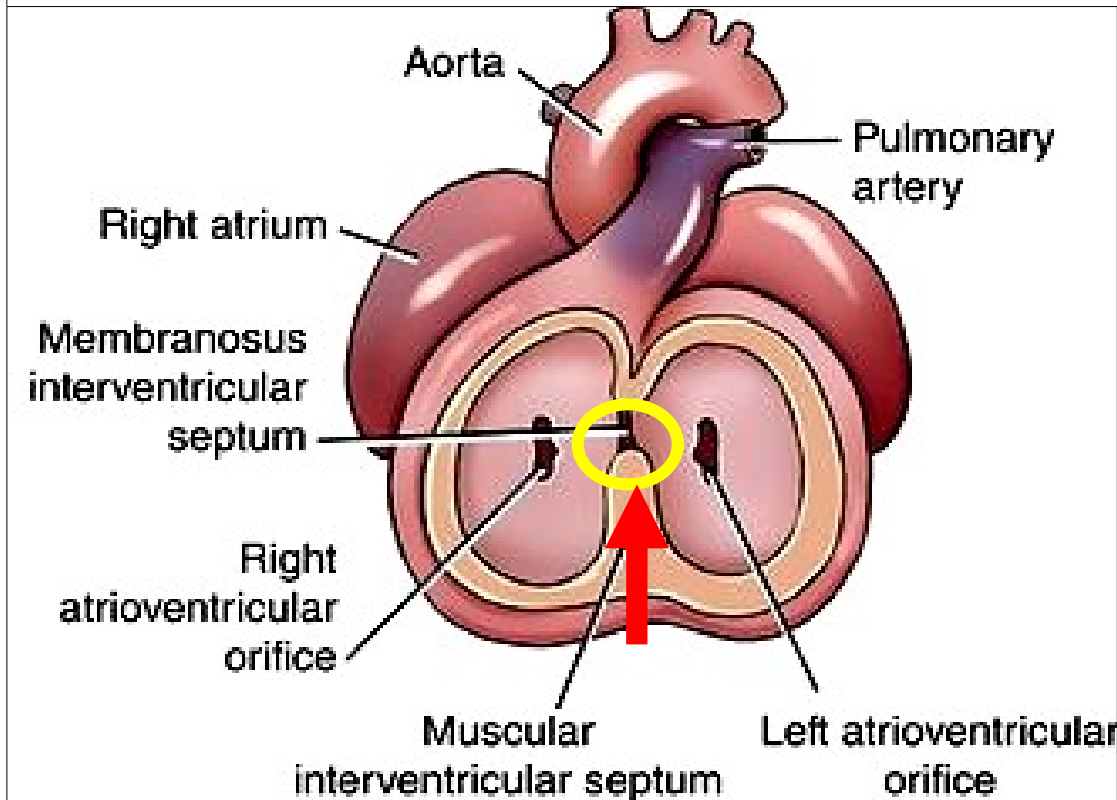
III. Partitioning of the primitive ventricle: [Formation of the interventricular septum]

-This chamber is divided into right & left halves by an interventricular (IV) septum which is formed of 2 parts:

1. Muscular part: A median crescentic ridge or fold grows upwards from the floor of the primitive ventricle.

-Up to **7th** week, there is a crescent-shaped **IV foramen** between the free edge of the IV septum & septum intermedium in AV canal → Temporary communication between the 2 ventricles.

2. Membranous part: It grows to fill the IV foramen by the end of 7th week.



IV.Partitioning of the bulbus cordis (conus cordis):

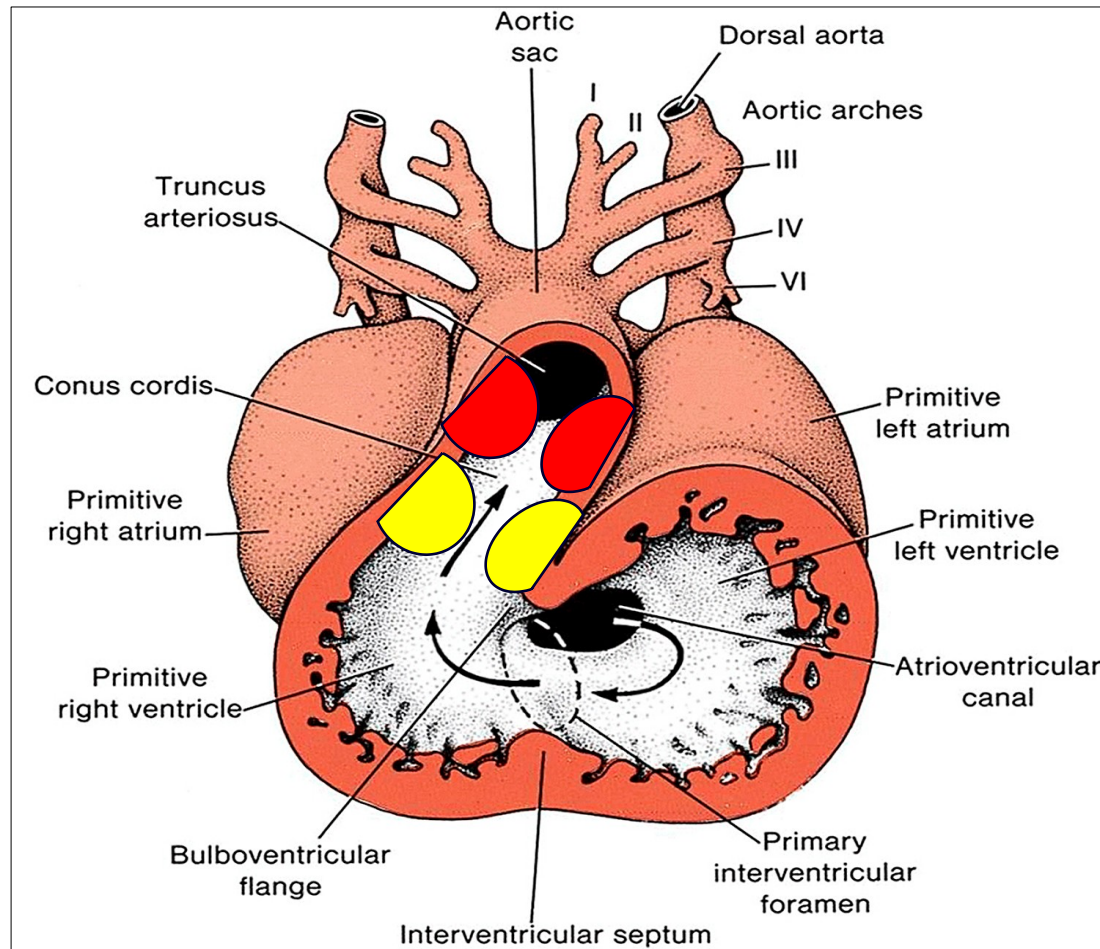
-Neural crest cells migrate into the mesoderm of the developing heart ⇒ Formation of bulbar ridges in bulbus cordis & truncal ridges in truncus arteriosus.

-Bulbus cordis is divided into 2 parts:

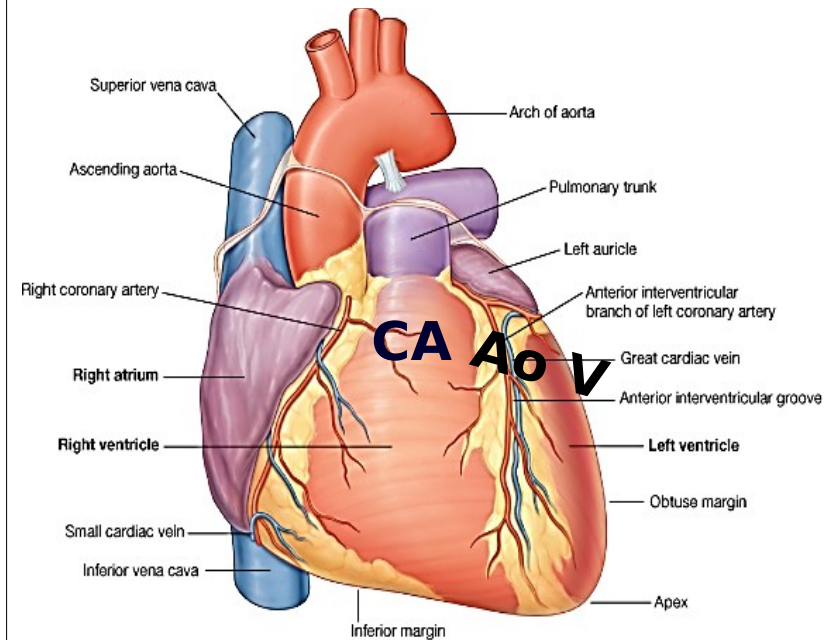
1.**Proximal part**: Right & left bulbar ridges fuse together to form the proximal bulbar septum ⇒ Formation of smooth outflow parts of both ventricles: **Infundibulum** (**conus arteriosus**) of right ventricle & **aortic vestibule** of left ventricle.

2.**Distal part**: It is divided by the distal bulbar septum into pulmonary orifice of right ventricle *anteriorly* & aortic orifice of left ventricle *posteriorly*.

Partitioning of the bulbus cordis (conus cordis)



Langman: Medical embryology; 14th edition



Gray's anatomy for students, 3rd Edition

Important note



-Right ventricle develops from **2 sources**:

1. Right $\frac{1}{2}$ of primitive ventricle \Rightarrow Rough (trabeculated) inflow part.

2. Ventral $\frac{1}{2}$ of bulbus cordis (conus cordis) \Rightarrow Smooth outflow part:

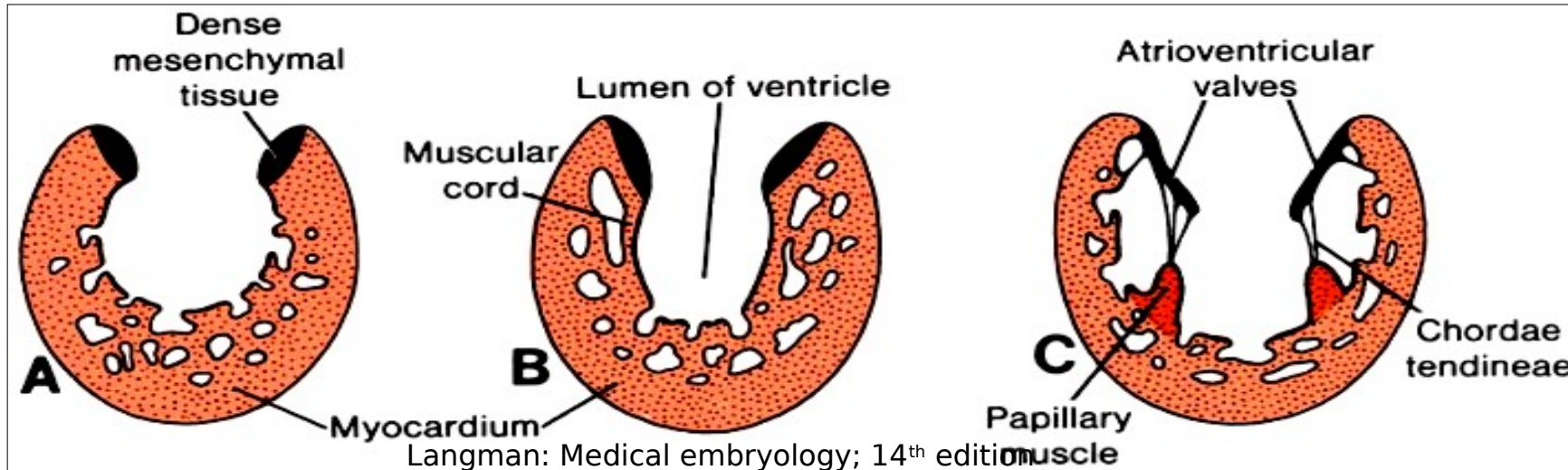
-Left ventricle also develops from **2 sources**:

1. Left $\frac{1}{2}$ of primitive ventricle \Rightarrow Rough (trabeculated) inflow part.

2. Dorsal $\frac{1}{2}$ of bulbus cordis (conus cordis) \Rightarrow Smooth outflow part: **Aortic vestibule**.

■ Inner layer of myocardium of each ventricle undergoes cavitation \rightarrow Formation of the trabeculae.





Cavitation of inner layer of myocardium

V.Partitioning of the truncus arteriosus (TA):

-The upper part of TA is dilated & forms the aortic sac.

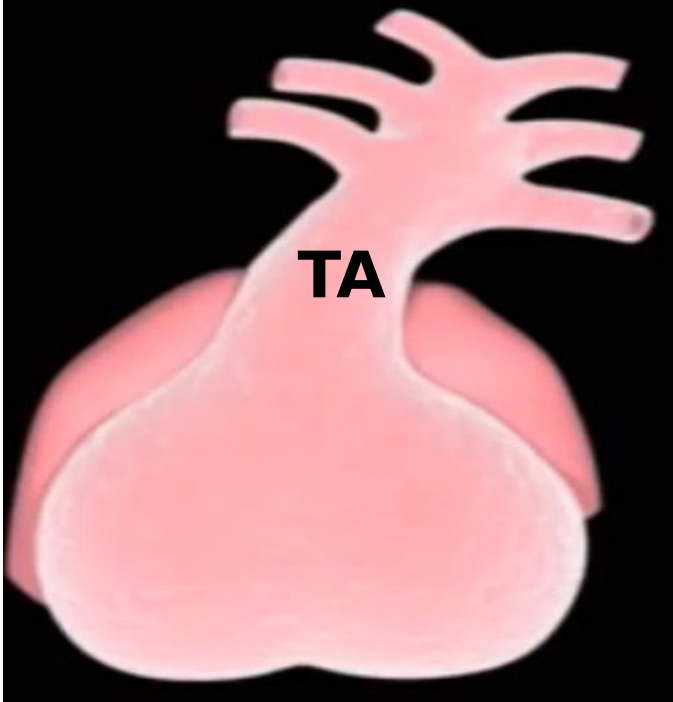
-In lower part of TA: Truncal ridges (*by neural crest cells*) fuse together & undergo spiraling by streaming of the blood from the ventricles

→ Formation of the **spiral aortico-pulmonary**

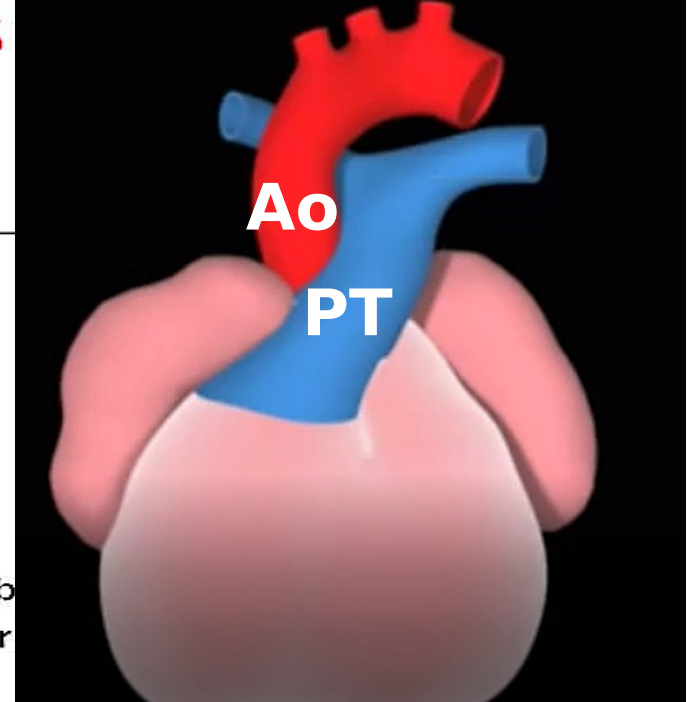
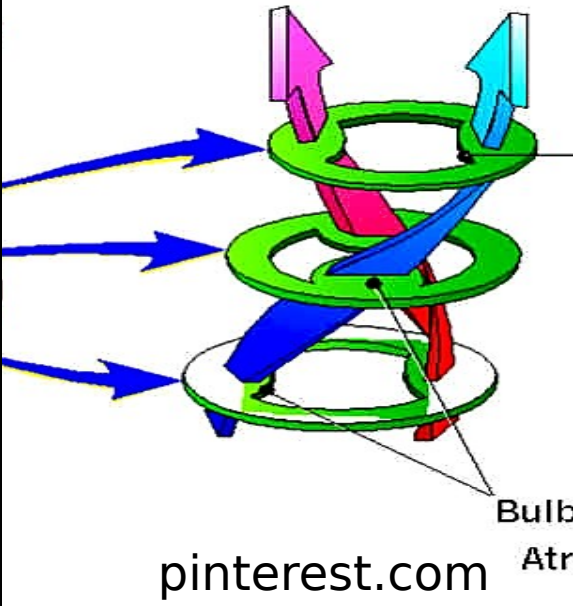
septum → Divides TA into pulmonary trunk & ascending aorta
 trunk twisting around the ascending aorta

[anterior then left then posterior].

waterloo



5 weeks

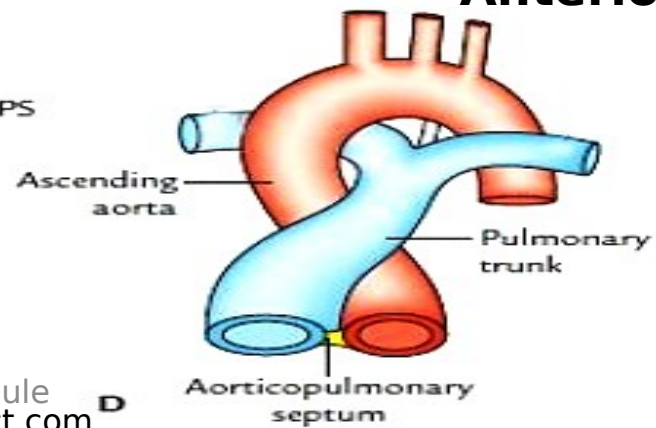
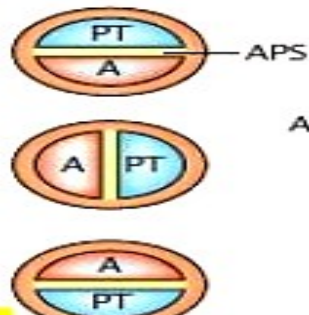
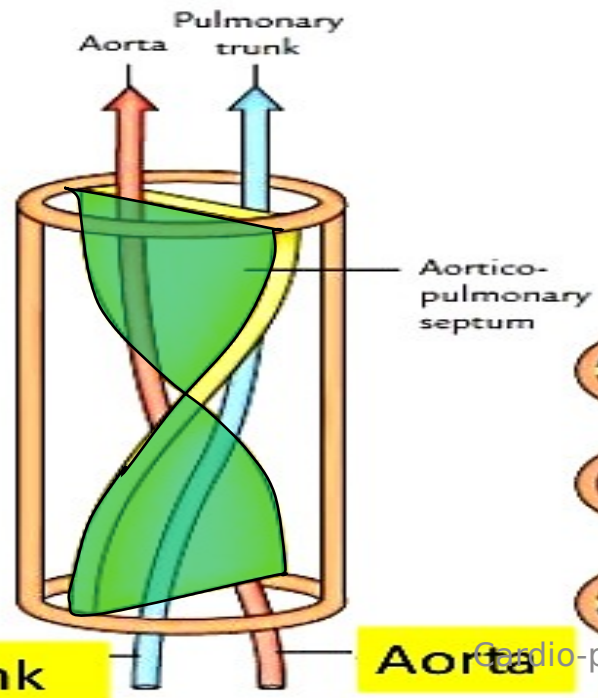


Spiral septum

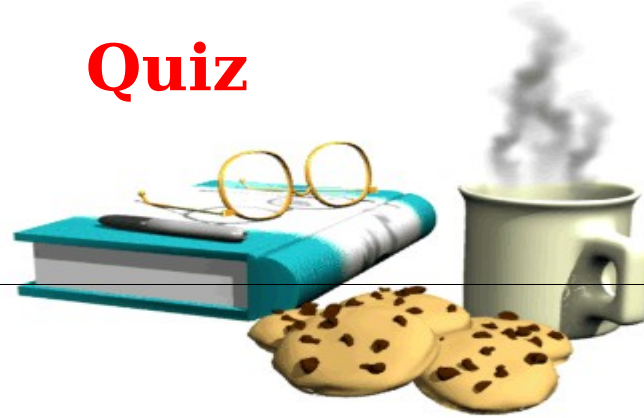
Posterior

Rt. ← → Lt.

Anterior



Quiz



- Enumerate 6 cardiac septa sharing in portioning of the heart during 4th - 8th week of development.
- Mention the primordia (sources) of the following CVS structures: Left ventricle - Coronary venous sinus - Conus arteriosus - Pulmonary trunk.

Anomalies of the heart & great vessels

Congenital heart defects

.Causes: (CHDs)

1.Genetic factors (chromosomal anomalies as Turner & Down syndromes).

2.Environmental factors (teratogens as rubella virus).

.Incidence: 6 - 8 / 1000 births.

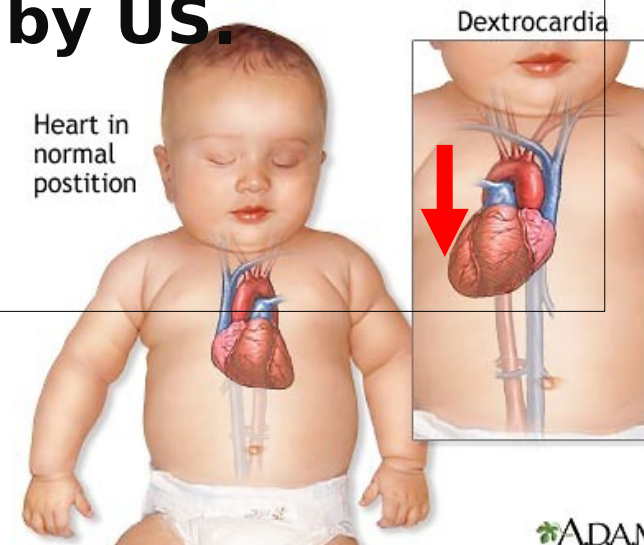
.Early diagnosis could be done by US.

1.**Abnormal position:**

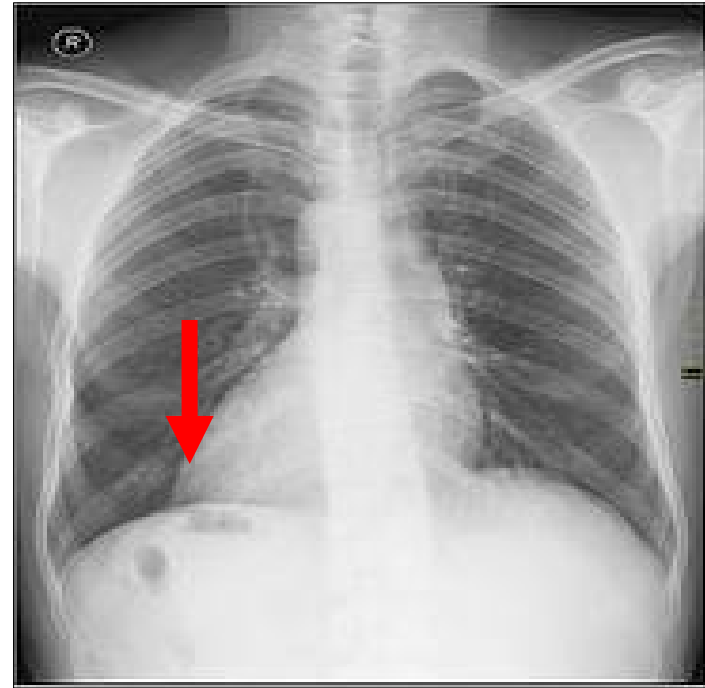
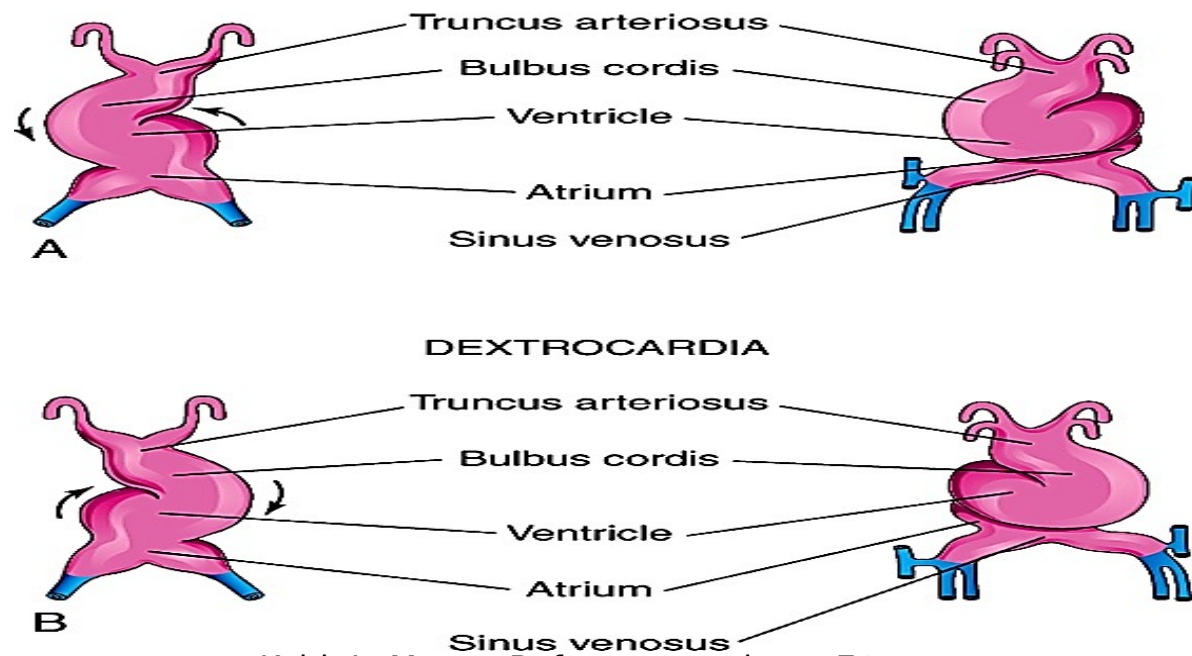
a.**Dextrocardia:** i.e. Apex to the right.

-Heart tube bends to the left instead of the right ⇒ Right-sided heart.

-May be isolated or a part of

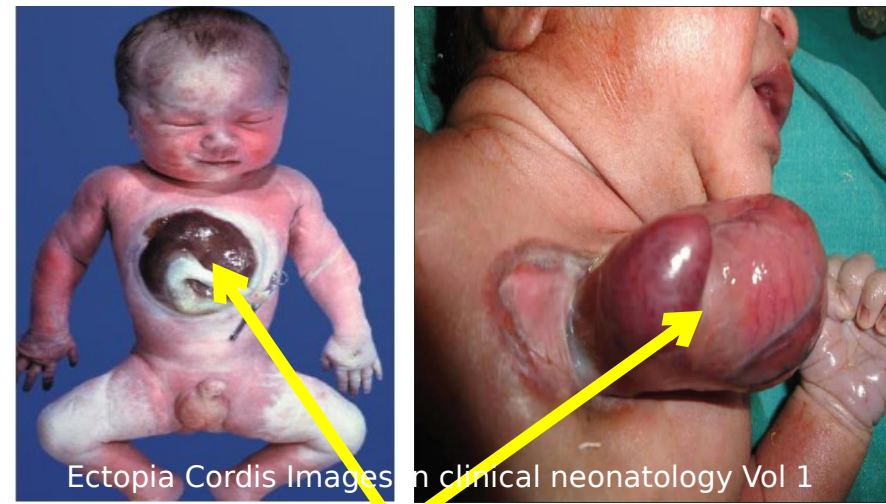


WUJCC



Keith L. Moore: Before we are born, 7th edition
Dextrocardia

b. Ectopia cordis:
-Heart is located outside the thoracic cavity through a bifid sternum.



Ectopia cordis

2. Atrial septal defects (ASDs): Right -to- left shunt of venous blood \Rightarrow Cyanosis

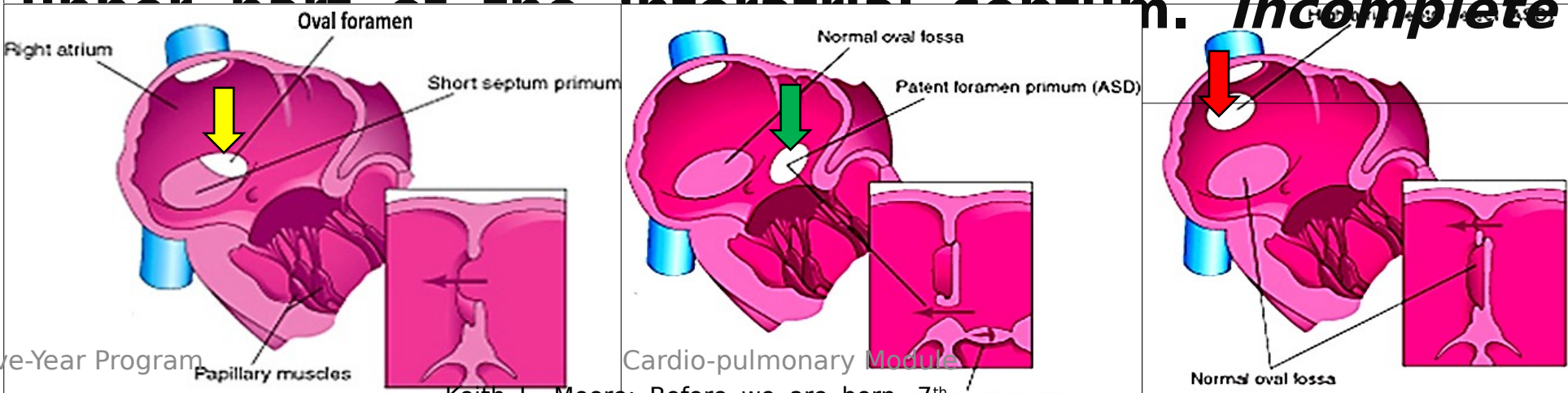
-ASDs are more common in females.

-4 types:

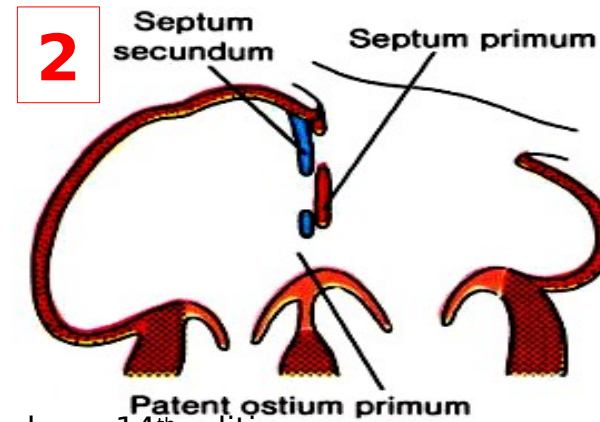
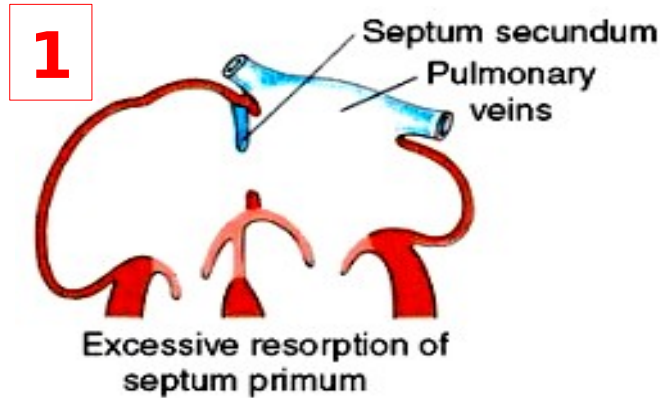
a. Patent foramen ovale: Commonest type. A hole in the middle of the interatrial septum (site of the fossa ovalis).

b. patent foramen primum: A hole in the lower part of the interatrial septum \pm Persistent AV canal.

c. Sinus venosus ASD (high ASD): A hole in the upper part of the interatrial septum. **Incomplete**

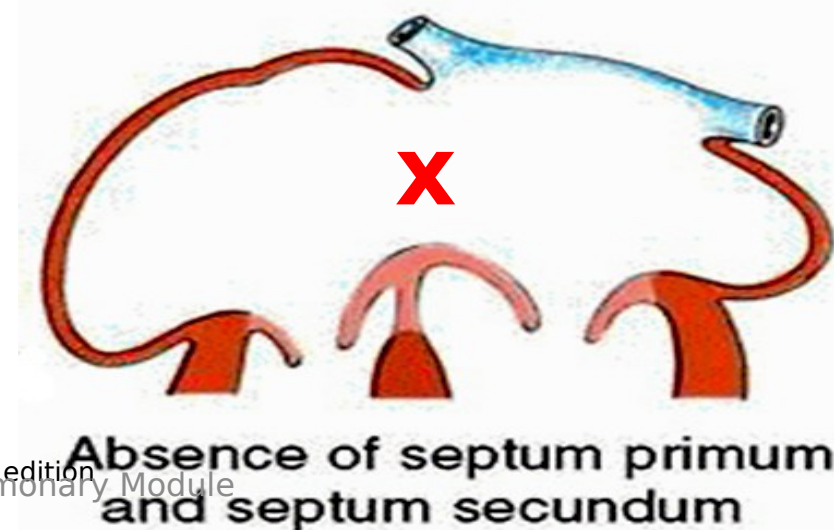
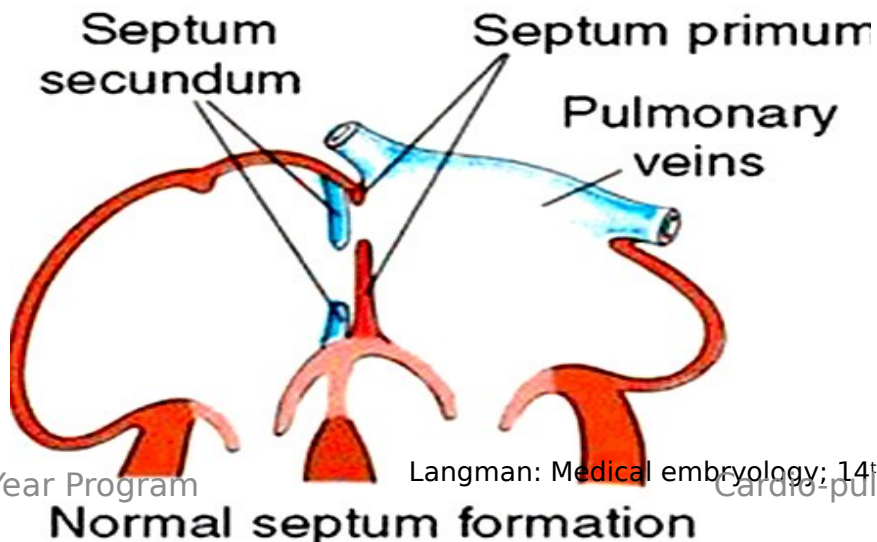


Identify the anomaly



Langman: Medical embryology; 14th edition

d.Common atrium: Absence of both septum primum & septum secundum ⇒ **Trilocular biventricular heart (1 atrium & 2 ventricles).**



3. **Ventricular septal defects (VSDs):**

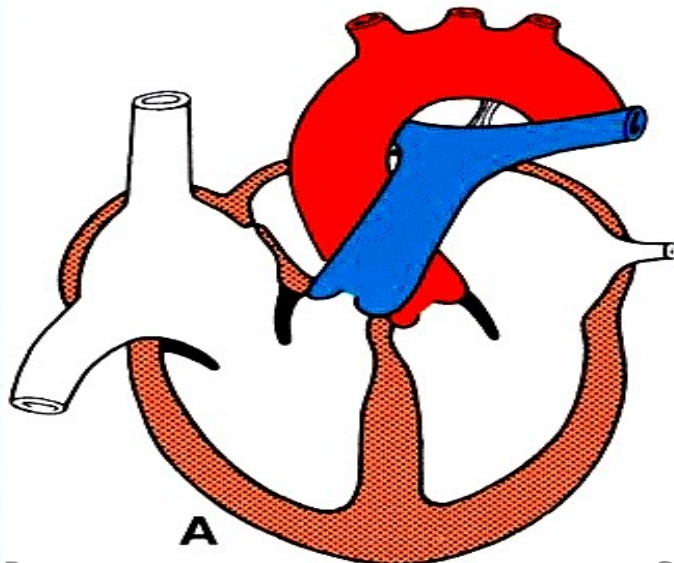
-VSDs are the most common type of CHDs, accounting for about 25% of cases. **VSDs may accompany other CHDs.**

-They are more common in males.

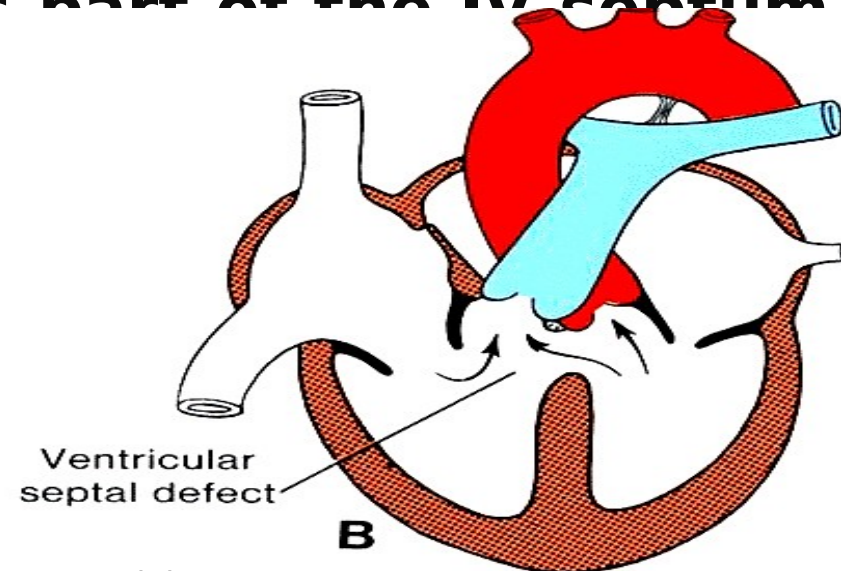
-**3 types:**

a. Membranous VSD (Roger's disease):
Commonest type.

-Absence of membranous part of the IV septum →



Normal

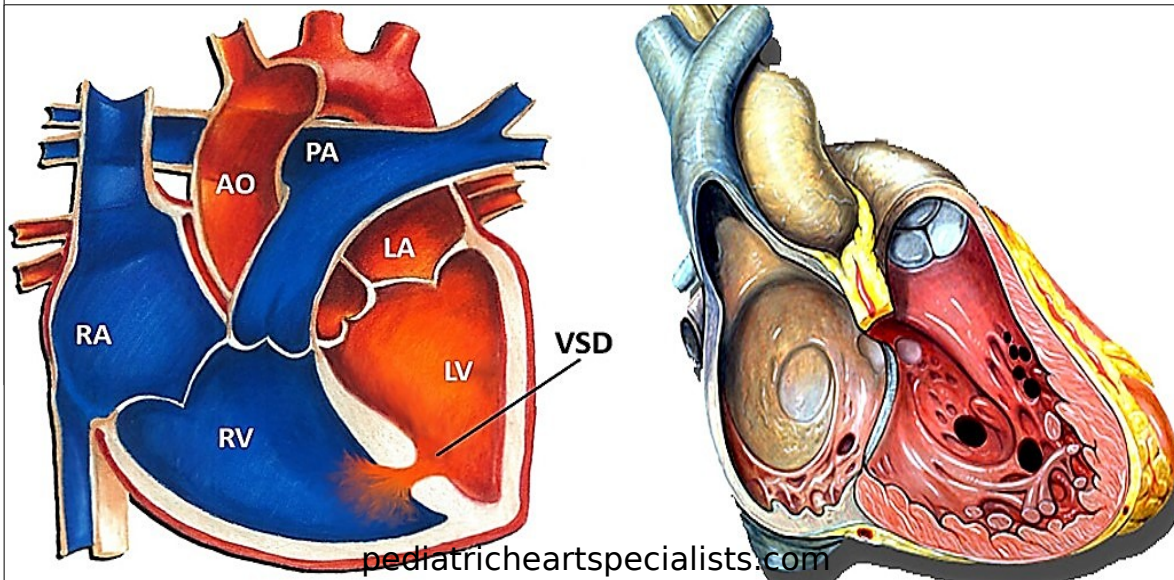


Roger's disease

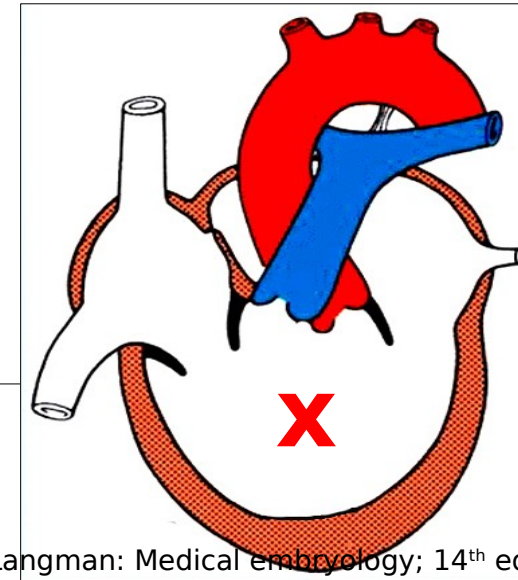
b.Muscular VSD:

-A hole or multiple holes (Swiss-cheese VSD**) in muscular part of IV septum.**

c.Common ventricle: Absence of IV septum ⇒ **Trilocular biatrial heart (2 atria & 1 ventricle).**



Muscular VSD



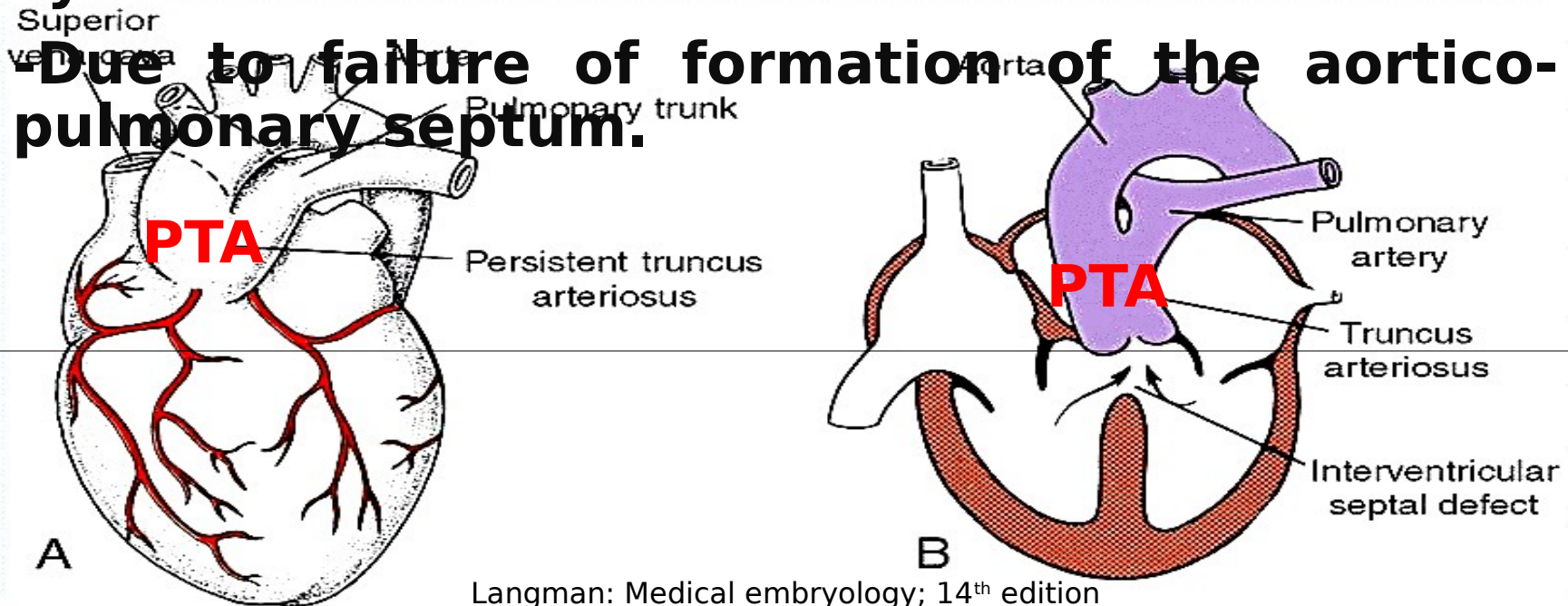
Common ventricle

4. **Abnormal division of the truncus arteriosus:** **4 cases**

A-Persistent truncus arteriosus (PTA):

-One vessel receives blood from both ventricles & distributes it to the pulmonary & systemic circulation.

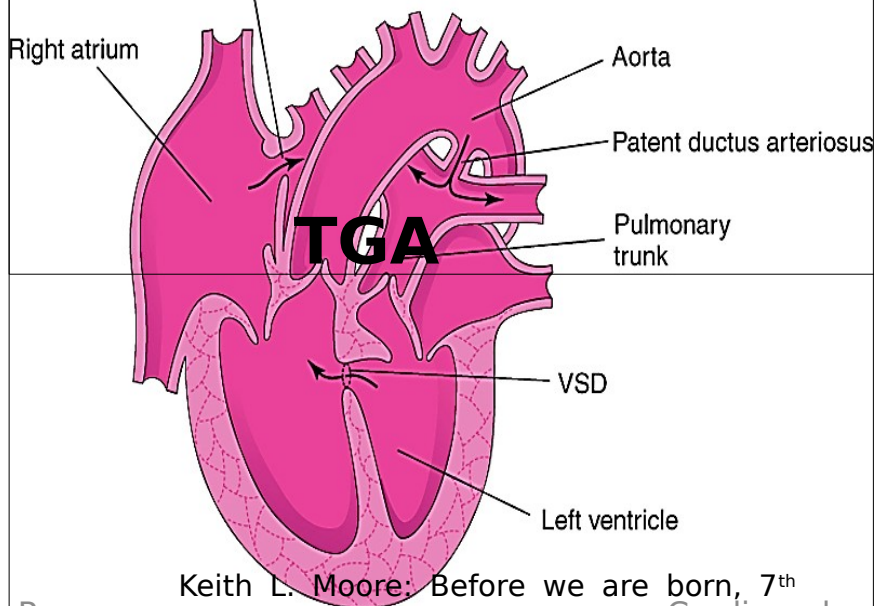
-Due to failure of formation of the aortico-pulmonary septum.



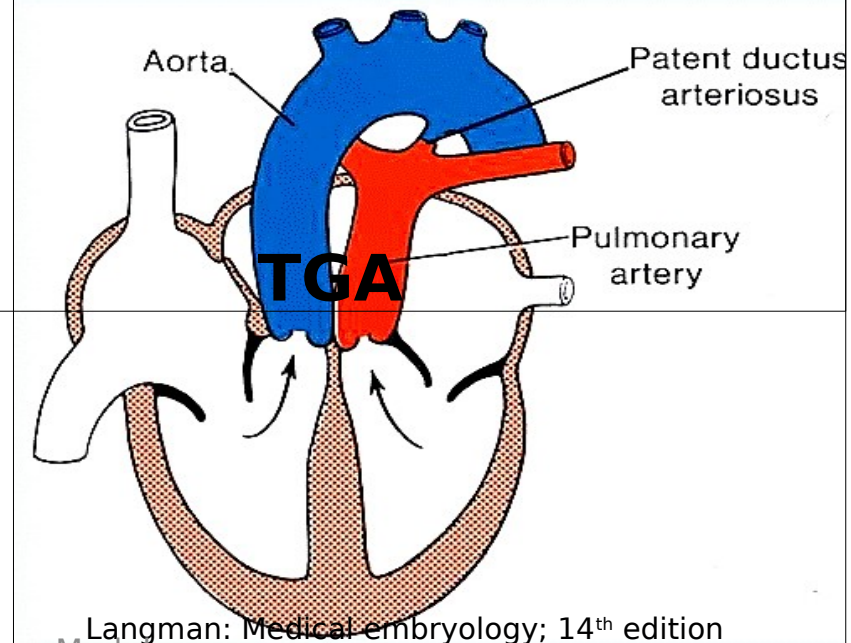
Langman: Medical embryology; 14th edition

B-Transposition of great arteries (TGA):

- Aorta arises from the right ventricle & pulmonary trunk arises from the left ventricle.**
- It is the 2nd most common cyanotic heart disease in newborn infants.**
- Due to formation of non-spiral aortico-pulmonary septum.**



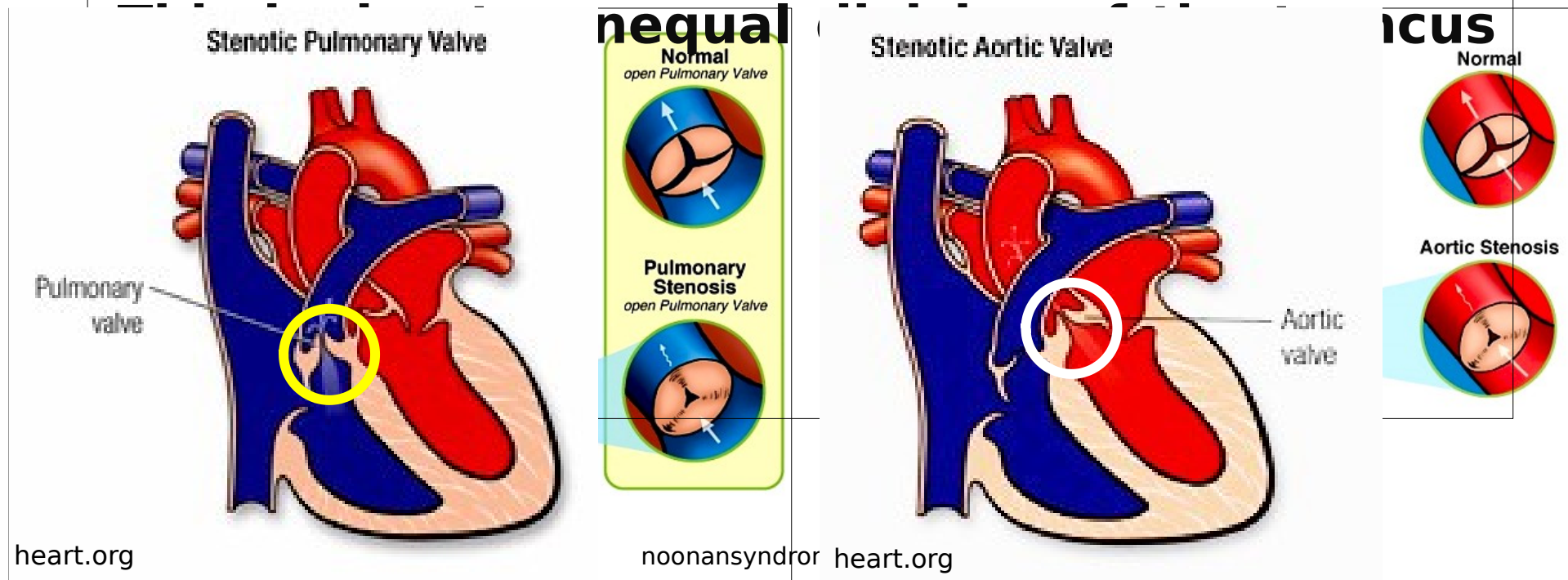
Keith L. Moore: Before we are born, 7th edition



Langman: Medical embryology; 14th edition

C-Congenital stenosis or atresia of pulmonary or aortic orifice:

-Stenosis means narrowing & Atresia means closure.



D-Tetralogy of Fallot:

-It is the commonest cause of neonatal cyanosis (**blue baby**).

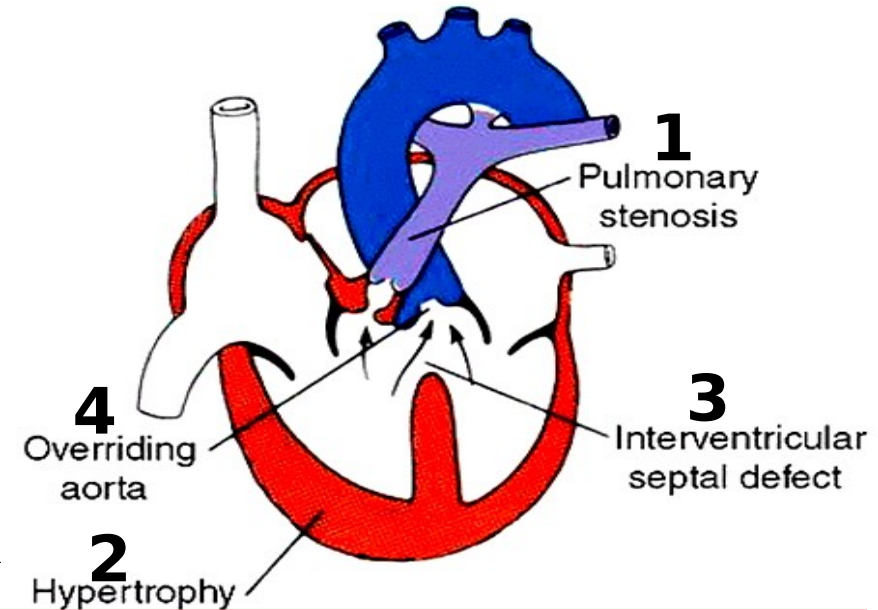
-This is also due to 4 cardiac anomalies:

1. Pulmonary stenosis.

2. Hypertrophy of right ventricle. *2ry to the pulmonary stenosis*

3. Membranous VSD.

4. Overriding of aorta on the ventricular septum

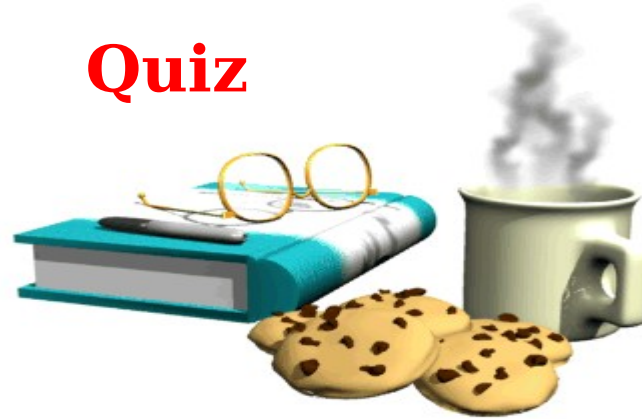


Langman: Medical Embryology: 14th edition



ASD is the commonest CHD (especially the ventricular type). Fallot's tetralogy is the commonest cause of neonatal cyanosis & TGA is the 2nd commonest cause.

Quiz



■The commonest CHD is
while, the 2nd commonest cyanotic heart
disease is

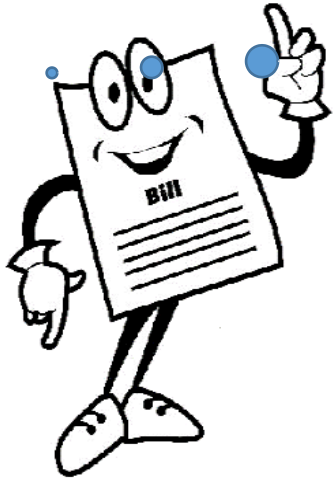
Identify the



Lecture Summary



Cardiac septa



-6 cardiac septa develop between 4th - 8th weeks induced by cardiac jelly.

.Septum intermedium in A-V canal, Interatrial septum, interventricular septum, proximal & distal bulbar septa and aorticopulmonary (spiral) septum.

-VSD is the commonest CHD (especially membranous type). Fallot's tetralogy is the commonest cause of neonatal cyanosis & TGA is the 2nd commonest cause.

■ *Tetralogy of Fallot* includes 4 cardiac anomalies:
Pulmonary stenosis - Hypertrophy of right ventricle
- Membranous VSD & Overriding aorta.

SUGGESTED TEXTBOOKS



1. Keith L. Moore: Before we are born, essentials of embryology and birth defects; 7th edition.
2. Langman: Medical embryology; 14th edition.
3. Web sites: <https://studentconsult.inkling.com/>
<https://www.clinicalkey.com/student>

BEST WISHES